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The Health State of the Cryosphere

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The term cryosphere is used to refer to all portions of the Earth surface where water appears in solid form. This includes the snow cover; sea, lake and river ice; glaciers, ice caps and ice sheets; and permafrost. The aim of this contribution is to present the current state of the cryosphere. Emphasis will be given to sea ice and continental ice masses (glaciers, ice caps and ice sheets), and the contribution of the losses from the latter to sea level rise (SLR).

The most recent consensus on the land-ice losses, and their contribution to SLR, was reached in the last Intergovernmental Panel on Climate Change report (IPCC, 2007), and is summarized below

(Source: IPCC 2007)	Sea level rise rate (mm/year)	
Origin	1961-2003	1993-2003
Thermal expansion of ocean waters	0.42 ± 0.12	1.6 ± 0.5
Melt/discharge from glaciers and ice caps	0.50 ± 0.18	0.77 ± 0.22
Melt/discharge from Greenland Ice Sheet	0.05 ± 0.12	0.21 ± 0.07
Melt/discharge from Antarctic Ice Sheet	0.14 ± 0.41	0.21 ± 0.35
Sum of contributions	1.1 ± 0.5	2.8 ± 0.7
Observed sea level rise	1.8 ± 0.5	3.1 ± 0.7
Difference observations-estimates	0.7 ± 0.7	0.3 ± 1.0

Recent corrections to some of the above data, as well as new data for time periods closer to present, will also be discussed. The main techniques for estimating the mass balance of the large ice sheets of Greenland and Antarctica (whose contributions to SLR are given above) will be introduced.

A remarkable feature shown in the above table is the fact that the small glaciers and ice caps, in spite of involving a total ice volume less than one hundredth of that of the sum of the Greenland and Antarctic ice sheets, is contributing to SLR in a larger proportion, and it is expected that this will continue to be so at least until the end of the XXI century.

Concerning sea ice, the different behaviour of the sea ice cover of the Arctic and Antarctic oceans during the last decades will be emphasized. While the Arctic sea ice extent has shown a clear decreasing trend (especially remarkable in the case of the end-of-summer extent), the Antarctic sea ice has remained nearly stable, even slightly increased during the same period.

A continued reduction of the Arctic sea ice extent would have various implications, sometimes of opposite sign. For instance, while the reduction in albedo would imply a positive feedback contributing to a further decrease of the sea ice extent (and thus a larger absorption of solar radiation by the ocean, and hence warming), having larger areas of the ocean in contact with the atmosphere would imply a larger absorption of CO_2 by the oceans, thus contributing to cooling. Alterations of the meteorological patterns, a decrease of the biodiversity and the opening of new navigation routes during the summer are some other implications of the decrease in Arctic sea ice extent.

REFERENCE:

IPCC (2007). Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis*. Contribution of Working Group I to the Fourth Assessment Report of the IPCC. Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller, Eds. Cambridge University Press.